Short Course on Experimental Dynamic Substructuring

Module #3: An industrial example

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Short Course Notes For:
January 23, 2016, IMAC, Orlando, Florida

Example 1 – FBS on a full car

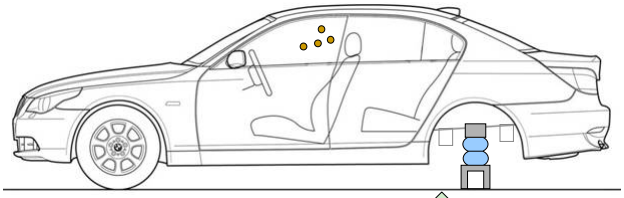
This example is taken from the PhD thesis of Dennis de Klerk

D. de Klerk. *Dynamic Response Characterization of Complex Systems through Operational Identification and Dynamic Substructuring: An application to gear noise propagation in the automotive industry.* PhD thesis, Delft University of Technology, Delft, The Netherlands, March 2009.

(download at repository of TU Delft library)

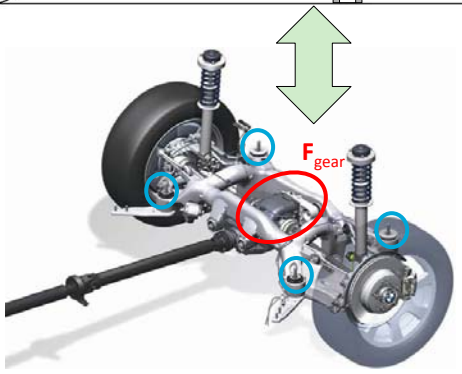
financed by BMW (D. Rixen supervisor)

Example 1 – FBS on a full car



Predict the noise propagation

from differential to driver‘s ear.



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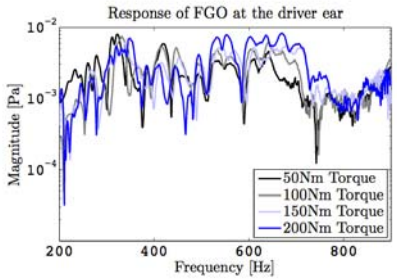

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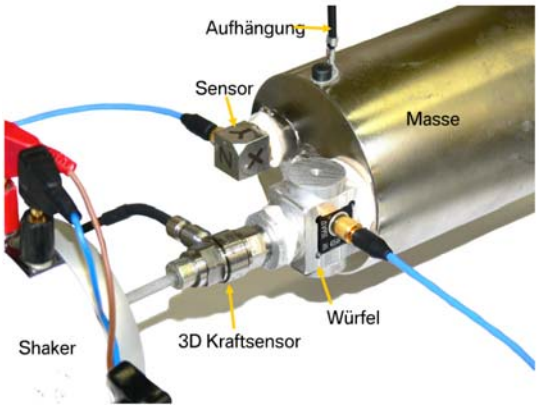
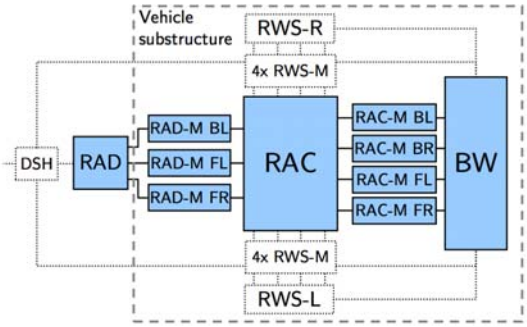


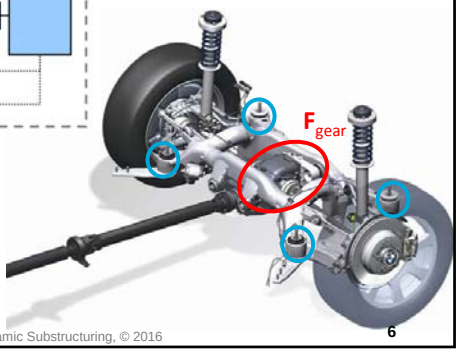
Important to have excellent measurements with small positioning errors

→ measurement of driving points by exciting directly on a 3D-accelerometer

Example 1 – FBS on a full car

First approach: considering all subcomponents (measured or FE)





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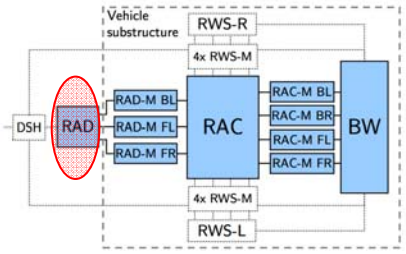

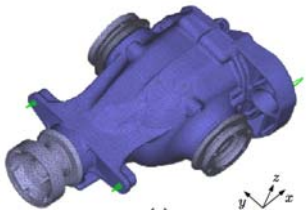

FE model and measurements give very similar FRFs (mainly rigid)

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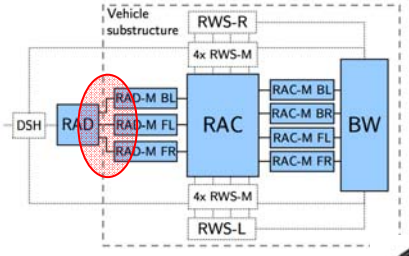

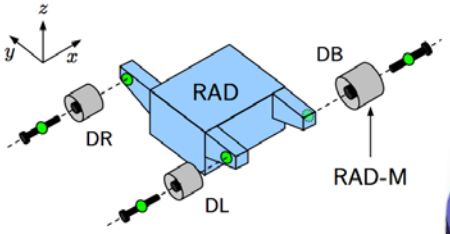

● - FE interface node (all DoF)

Legend:

1: Core
2: Lower Shell
3: Upper Shell
4: Rubber

only FE model

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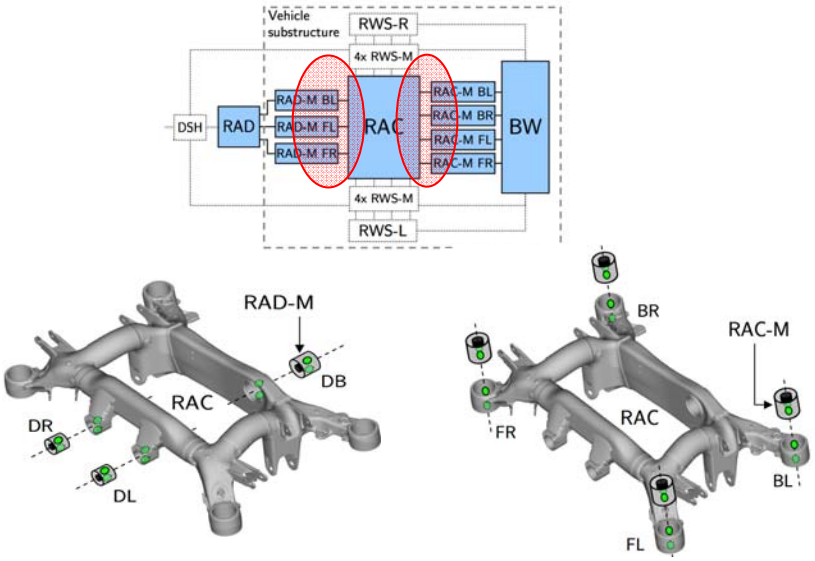

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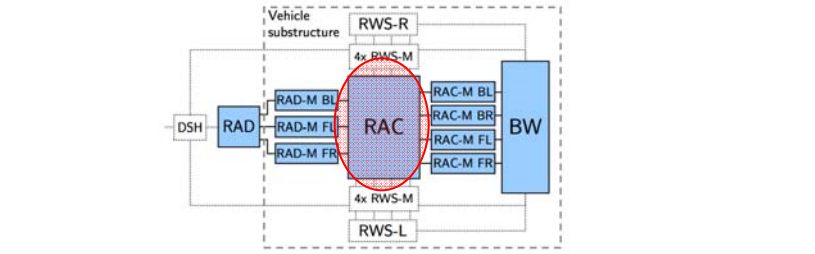

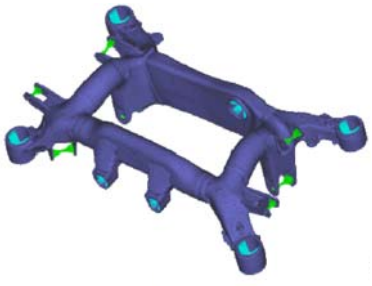

Excellent agreement FE / measurements

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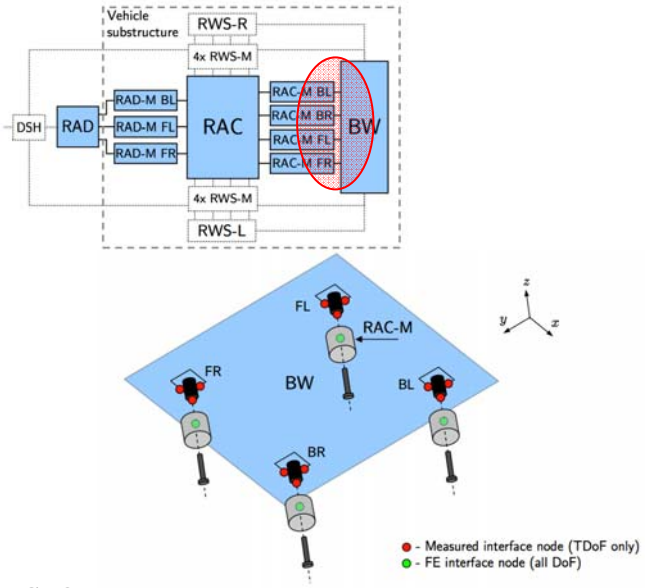
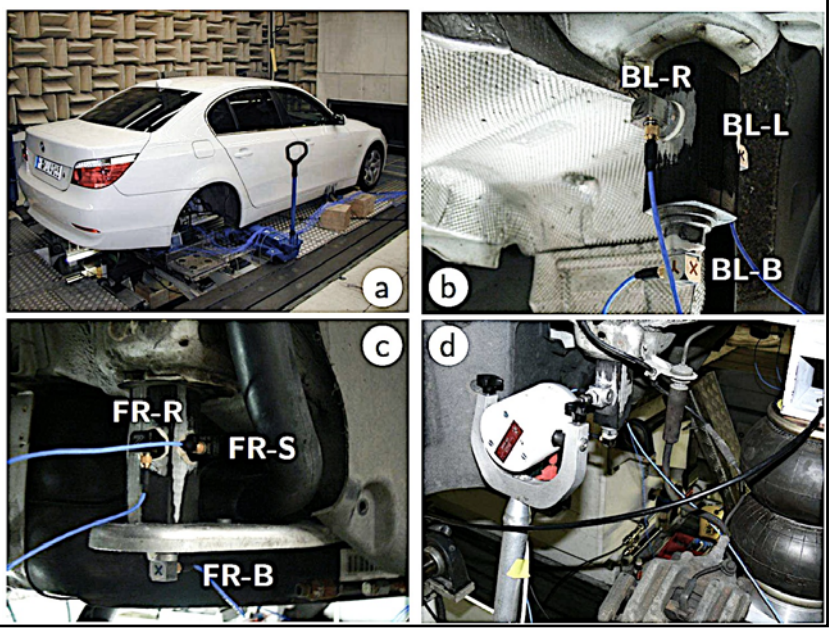


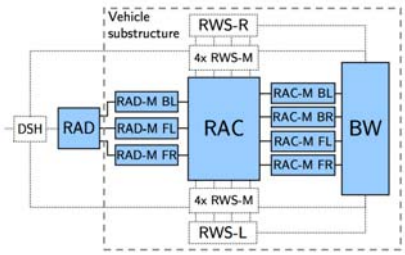
Example 1 – FBS on a full car

Body in white

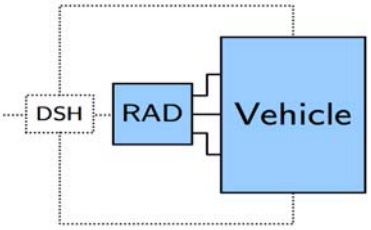


Example 1 – FBS on a full car

First approach: considering all subcomponents (measured or FE): see before



Second approach: only 2 components RAD + rest



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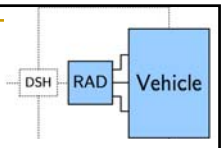
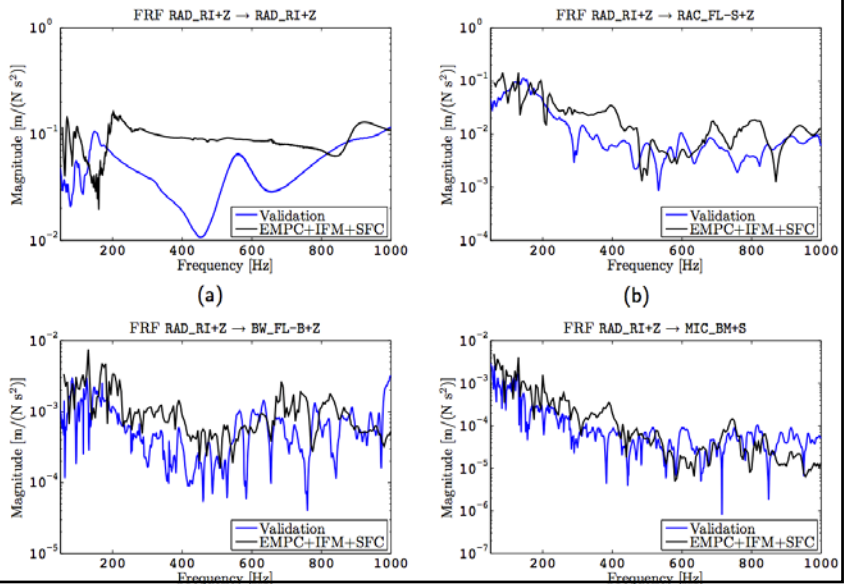


Validation results



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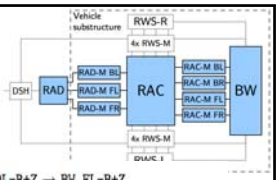

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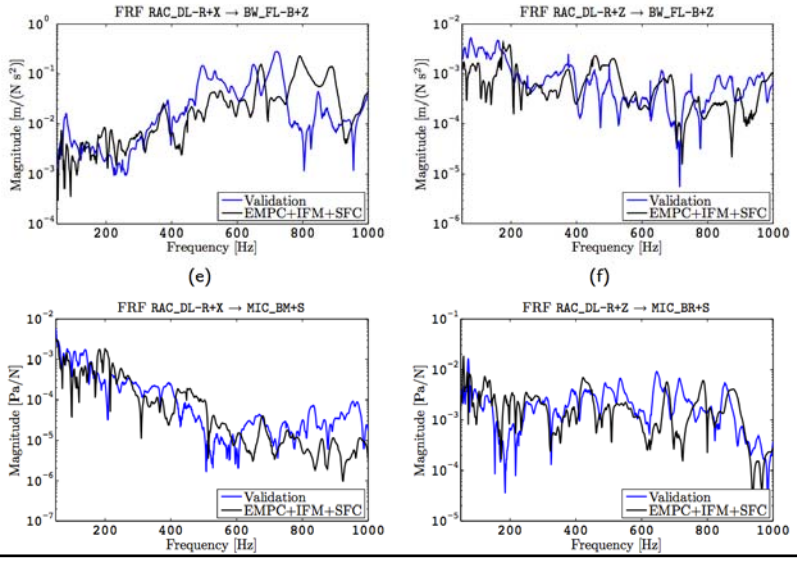


Example 2 – FBS on steering gear assembly

This work is currently performed by Maarten vd Seijs

(D. de Klerk & D. Rixen supervisors)

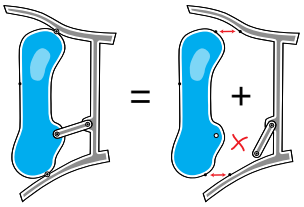
Extracts from

M. van der Seijs, D. de Klerk, D. Rixen, and S. Rahimi. Validation of current state frequency based substructuring technology for the characterisation of steering gear – vehicle interaction. In *IMAC-XXXI: International Modal Analysis Conference, Garden Grove, California USA*, Bethel, CT, February Feb. 11-14, 2013. Society for Experimental Mechanics.

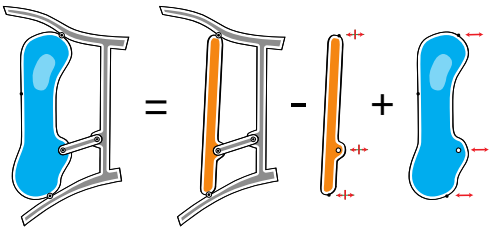
M. V. van der Seijs, D. D. van den Bosch, D. J. Rixen, and D. de Klerk. An improved methodology for the virtual point transformation of measured frequency response functions in dynamic substructuring. In M. Papadrakakis, V. Papadopoulos, and V. Plevris, editors, *COMPDYN 2013 4th ECCOMAS Thematic Conference on Computational Methods in Structural Dynamics and Earthquake Engineering*, Kos Island, 12–14 June 2013.

Example 2 – FBS on steering gear assembly

Aim: predict the vibration transfer between steering gear and steering wheel



Use of a substitute (transmission simulator) during component measurement to improve measurements (see MOD07)



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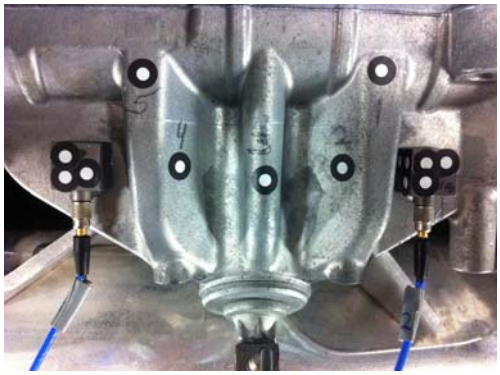
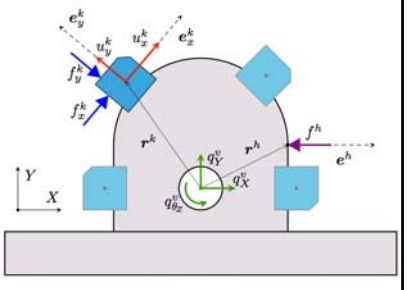
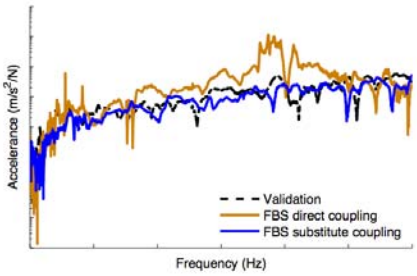




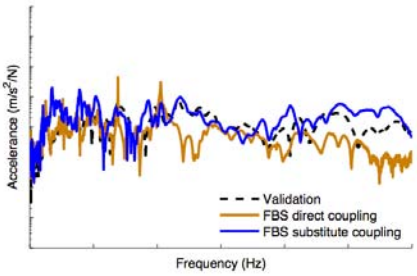
FRFs on connecting points measured with EMPC (virtual Point) technique and positions of sensors measured by photogrammetry

Example 2 – FBS on steering gear assembly

Validation results



(a) Transfer between the bolted connections points.



(b) Transfer from the steering gear to the steering wheel.